Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, DC 20554

In the Matter of

Use of the 5.850-5.925 GHz Band

E.T. Docket No. 19-138

Reply Comment

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Ann Arbor, MI

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1 INTRODUCTION

I submit this comment as an individual representing only myself. This comment does not reflect the view of my employer or any organization with which I am affiliated.

I am a passionate advocate of improving the safety, efficiency, and equity of surface transportation in the United States. I have reviewed most comments submitted to the docket by the leading industry groups and large corporations who advocate for licensed V2X spectrum to build out a national safety-critical ITS wireless network (as of the June 3rd deadline for initial comments). I am concerned that the Commission is receiving an inaccurate description of V2X technology from many commenters, and I desire to correct the record.

However, I will not be referencing specific previous comments; there are two main reasons for this. The first is that I will be focusing on topics for which there is near-consensus among these groups, and thus there is no benefit in making distinctions. The second reason for not addressing individual comments is that I do not wish for my reply comment to be interpreted as adversarial. I believe that these groups who advocate for the "safety spectrum" do so in good faith but have reached sub-optimal policy positions due to an incomplete understanding of available research and group-think dynamics. I believe that if V2X advocates were to earnestly re-examine their positions by reference to the source material that they cite, they will willingly adjust their views on the matter.

This comment does not take any position regarding regulation of the 5.9 GHz spectrum. The intent of this comment is to evaluate the foundational assumptions of commenters who assert that V2X is a proven and valuable safety critical technology. In this comment, I will show that there is no justification for such a belief.

2 V2X ADVOCATE CLAIMS EVALUATED

I will not be responding directly to positions taken by other commenters or the advice given to the Commission. Instead, I will be addressing core assumptions that many commenters share in common but have adopted in error. The specific foundational claims that I challenge are:

- V2X will prevent or mitigate up to 80-90% of crashes
- Under the current Report and Order, interference from Wi-Fi devices will compromise V2X safety-of-life applications
- 30 MHz is not sufficient for ITS operations
- V2X is mature and deployment-ready

2.1 Claim: V2X will prevent or mitigate up to 80-90% of crashes

V2X advocates claim that a connected vehicle-based ITS system could prevent or mitigate most crashes. This claim can usually be traced back to one or more of the documents referenced below.

National Motor Vehicle Crash Causation Survey (2008)[1]

A C*rash Statistics Brief* published by NHTSA in 2015 provided a summary table that listed *drivers* as the critical reason for crash occurrences in 94% of light vehicle crashes.[2] This brief describes the results of the above-referenced Crash Causation Survey report published in 2008. The 2008 report describes a well-designed research effort with justified conclusions. The 2015 fact sheet is an earnest and accurate interpretation of the study. But neither of these documents state that human error is the *cause* of 94% of traffic crashes.

NHTSA takes care to emphasize that, "although the *critical reason* is an important part of the description of events leading up to the crash, it is not intended to be interpreted as the *cause* of the crash nor as the assignment of the fault to the driver, vehicle, or environment."[3] The *critical reason* is defined as the "last event

[1] USDOT NHTSA. "National Motor Vehicle Crash Causation Survey." Report to Congress. July 2008.

[2] USDOT NHTSA. "Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey." February 2015.

[3] Idem p. 1.

in a crash causal chain."[4] It is not necessarily the most important factor, nor an optimal point of intervention for crash prevention.

Moreover, this research is not constructed or intended to evaluate technology interventions such as vehicle connectivity or automation as a crash-prevention tool. Any reference to this source suggesting that V2X is likely to prevent crashes is a misuse of the work.[5,6]

Frequency of Target Crashes for IntelliDrive Safety Systems (2010)[7]

This report estimates the frequency of different crash types that would potentially be addressed by the USDOT IntelliDrive Program (which evolved into today's USDOT Connected Vehicle Program). The report concludes that a mature V2X environment could "potentially address … about 81% of all-vehicle target crashes."[8] The research methodology is appropriate and the conclusions are justified.

However, the conclusions are taken out of context by V2X advocates. First, the "target crashes" reference a limited subset of *all* vehicle crashes; this should not be extrapolated to make general statements without careful attention to details regarding how crash data were obtained, processed, and analyzed. Second, the authors use the phrase, "potentially address"—a semantic detail that is easily overlooked but important. This report does *not* claim that a mature V2X network is likely to prevent or mitigate *any* number of vehicle crashes. The claim is only that there is *potential* to *address* such crashes—subject to a series of assumptions that must be validated.[9]

More importantly, this 2010 report is out of date. NHTSA funded this effort to inform the development of V2X applications and justify further research and investment in the USDOT Connected Vehicle program. Additional research *was* conducted to validate the assumptions used to derive the initial estimates. More

[4] Ibid.

[5] Don Kostelec. "The 94% Error: We Need to Understand the True Cause of Crashes." StreetsBlog USA. October 14, 2020.

[6] Bryant Walker Smith. "Human Error as a Cause for Vehicle Crashes." Stanford Law School Center for Internet and Society Blog. December 18, 2013.

[7] Wassim G. Najm, Jonathan Koopmann, John D. Smith, and John Brewer. "Frequency of Target Crashes for IntelliDrive Safety Systems." USDOT RITA Volpe. Funded by USDOT NHTSA. October 2010.

[8] Idem p. vi.

[9] Idem pp. 1-9 and Appendix B.

current and informed efforts should be considered to supersede this early work (some of which are discussed below).[10]

USDOT NHTSA V2V NPRM (2017)[11]

Many commenters cite the 2017 NHTSA Notice of Proposed Rule Making (NPRM) to mandate V2V as support for claims regarding crash reduction. The NPRM utilizes the line of Volpe research mentioned above,[12] in combination with crash data from the Fatality Analysis Supporting System (FARS) and General Estimates System (GES) from the years 2010-2013, to estimate the number of target crashes.[13] The agency estimated the benefits of the proposed rule by assuming that two safety applications (intersection movement assist [IMA] and left turn assist [LTA]) would be voluntarily adopted by automakers following a mandate for V2V connectivity. NHTSA chose these two applications, and only these two applications, because the agency found that other safety applications could be more effectively deployed with alternative technologies.[14]

NHTSA presumes that LTA and IMA will have only partial efficacy even under full deployment. NHTSA estimates that the success rate of LTA and IMA would be 43%-56% and 37%-63%, respectively. NHTSA subsequently estimates that V2X could prevent between 987 to 1,366 fatalities per year after 40 years of integration into the light vehicle fleet (required to reach near full adoption of V2V connectivity).[15]

Due to details in methodology, this estimate should be considered as highly uncertain, which NHTSA acknowledges. However, to demonstrate general order-

[10] In addition to subsequent field trials, this particular line of research itself has been refined and updated. See, e.g., Najm et al., "Description of Light Vehicle Pre-crash Scenarios for Safety Applications Based on Vehicle-to-Vehicle Communication." USDOT Volpe, NHTSA, 2013.

[11] USDOT NHTSA (Federal Register). 49 CFR Part 571 [Docket No. NHTSA-2016-0126] FMVSS V2V Communications. Notice of Proposed Rulemaking. January 12, 2017. Page references to the NPRM herein will refer to the unofficial web version, available at: https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/v2v_nprm_web_version.pdf

[12] I.e., *supra* page 2.

[13] NHTSA V2V NPRM p. 317.

[14] Idem pp. 17 and 315.

[15] Idem pp. 17 and 324.

of-magnitude efficacy of V2X, this represents between 2.5% and 3.5% of the estimated 38,680 fatalities suffered by U.S. road users in 2020.[16]

Furthermore, the NHTSA V2V NPRM is not relevant to the current FCC rulemaking. The NPRM would have mandated V2V connectivity based on DSRC technology. This FCC docket centers on access to licensed spectrum for C-V2X and does not include any mandated implementation.[17] Any V2X mandate now seems unlikely.[18] In the V2V NPRM, NHTSA emphasized a belief that a mandate would be necessary to compel adoption of V2X technology, stating, "the agency believes the market will not achieve sufficient coverage absent a mandate."[19] Nearly all commenters to the NHTSA V2V NPRM (and previous ANPRM) who addressed this issue agreed that a mandate would be required to achieve sufficient fleet adoption to enable safety applications.

Ann Arbor Safety Vehicle Model Deployment

The Ann Arbor Safety Model Deployment ran from 2012 to 2014 and included about 2,800 DSRC-equipped vehicles.[20] The project was *not* designed or intended to collect evidence on how well V2X safety applications worked; the intent was to determine radio interoperability.[21] Nevertheless, the project is the only research effort to date to provide an independent review of observed data on the efficacy of V2X applications.[22] A high-level overview of these findings is provided in Table 1 on page 6.

[16] USDOT NHTSA. Press Release: 2020 Fatality Data Showed Increased Traffic Fatalities During Pandemic. June 3, 2021.

[17] As mentioned by several commenters, most U.S. automakers have stated intent to deploy C-V2X *if* sufficient licensed ITS-centered spectrum is available. Details of this have not been presented, such as safety applications that would be adopted or enforcement mechanisms for following-through on such a pledge.

[18] The proposal for a V2V mandate has been removed from the list of regulatory actions being actively pursued by NHTSA in the current Unified Regulatory Agenda.

[19] NHTSA V2V NPRM p. 13.

[20] **Disclosure:** The author of this comment participated in the Model Deployment as a volunteer and received $500 compensation in exchange for having an aftermarket device transmitting the BSM from his 2003 Chevrolet Malibu. They broke my seat, also.

[21] NHTSA V2V NPRM p. 36.

[22] Emily Nodine, Scott Stevens, Andy Lam, Chris Jackson, and Wassim G. Najm. "Independent Evaluation of Light Vehicle Safety Applications Based on Vehicle-to-Vehicle Communications Used in the 2012-2013 Safety Pilot Model Deployment." Volpe/NHTSA. December 2015.

TABLE 1: THE SUCCESS RATES OF V2X SAFETY APPLICATIONS TRIALED IN THE ANN ARBOR MODEL DEPLOYMENT VARIED FROM 31% TO 94%.[23]

Application	Phase[24]	Sample size	Success Rate
Forward Collision Warning (FCW)	1	590	34%
	2	525	31%
Intersection Movement Assist (IMA)	1	901	39%
	2	126	94%
Blind-spot Warning (BSW) & Lane Change Warning (LCW)	1+2	242	54%

Independent analysis conducted by Volpe finds that V2X for safety is feasible but further research is needed to achieve applications capable of providing a safety benefit. Volpe concludes, "the model deployment was crucial in revealing areas for improving performance of the emerging DSRC technology and the prototype safety applications... Some of these improvements were corrected during the model deployment, while others require further research." [25]

[23] Data Source: Nodine et al. (Volpe) 2015.

[24] Software updates during the trial period may have impacted efficacy. To rule out this variance, Volpe statistically compared test results between the two phases. If there were significant differences, results were presented separately for each phase. If not, test results for the two phases were combined. (Idem pp. 38-39.)

[25] Nodine et al. (Volpe) pp. xii and 67.

USDOT Connected Vehicle Pilot Deployment Program

The USDOT CV Pilot Deployment Program was initially intended to collect data that would support the NHTSA V2V mandate.[26] Scheduled for completion in October 2020, the project timeline has slipped and the associated rulemaking has been postponed indefinitely. However, one of the three pilot sites has presented preliminary results (Table 2, below).[27]

TABLE 2: PRELIMINARY PERFORMANCE DATA FROM THE TAMPA CV DEPLOYMENT SITE SHOWS THAT MOST WARNINGS PROVIDED WERE FALSE POSITIVES. DATA IS NOT AVAILABLE FOR APPLICATIONS THAT WERE ABANDONED DUE TO TECHNICAL DIFFICULTIES.[28]

Application	Sample size	Success Rate
Forward Collision Warning (FCW) (Highway)	77	11.7%
FCW (Surface Street)	61	13.1%
Emergency Electronic Brake Light (EEBL) (Highway)	43	2.3%
EEBL (Surface Street)	4	25.0%
Wrong Way Entry	No data	
Pedestrian Collision Warning	87	18.4%
Transit Signal Priority	No data	
Streetcar Conflicts (Vehicle Turning Right In Front of Transit Vehicle)	64	6.2%
Intersection Movement Assist (IMA)	5	0.0%

These success rates are clearly not sufficient to move forward with deployment as to improve traffic safety without significant further refinement.

Conclusion

V2X advocates claim that the safety case of V2X is clear and proven. Such claims are based on misinterpretation or unawareness of available evidence. There is no data, research, or collection of evidence to justify assertions that V2X is a proven or viable tool for active safety and crash avoidance.

[26] Introduced *supra* p. 4.

[27] Full webinar recording is available at: https://itsa.adobeconnect.com/_a932559885/p2l0lrudkpl7/?proto=true Slides are available at: https://www.its.dot.gov/pilots/pdf/THEA_CVPilotPerformanceResultsTransitionPlan.pdf

[28] Date Source: Govind Vadakpat (USDOT), Bob Frey (THEA), Steve Novosad (HNTB), Sisinnio Concas (CUTR), and Achilleas Kourtellis (CUTR). *Tampa (THEA) CV Pilot Deployment Results and Transition Plan.* Webinar [slides]. January 25, 2021.

2.2 Claim: Under the current Report and Order, interference from Wi-Fi devices will compromise V2X safety-of-life applications

Multiple commenters express concern that the out-of-band emissions limits described in the Report and Order are insufficient to protect the remaining ITS spectrum. These commenters would benefit to reevaluate this stance from a practical, first-principles perspective. Interference in safety-critical ITS applications is a valid concern, but this concern exists regardless of the bandwidth allocated for licensed ITS uses.

If the intent of V2X is to support safety critical applications, *and* those applications are vulnerable to incidental interference, *then* V2X is not a viable approach to improve safety. Research has shown that rule-based protection of the 5.9 GHz band is not sufficient to maintain operations. For example, a "lessons learned" document from the ongoing CV Pilots observes the following:

> "During the deployment period, THEA detected and tracked down an interference on their DSRC communication channels coming from a local amateur radio operator. … The additional signal on THEA's channels impacted the performance of their equipment in terms of data exchange and back haul speed, with testing indicating a degradation in data uploads by up to 50%. Upon review of these findings, Florida Department of Transportation (acting as the enforcement agency) ordered the amateur radio operator to vacate the channel." [29]

Regulations preventing such interference cannot be relied on. In a mature V2X-based ITS environment, a bad actor could connect a 5.9 GHz antenna to a power source, broadcast interference, and cause havoc. If licensed radio spectrum becomes a critical component of the transportation system, it is likely that black and grey market devices will be sold to jam the spectrum, as GPS jammers currently are.[30] Even today, software-defined devices are available that could be used to jam 5.9 GHz wireless operations with just a bit of expertise.[31] The commercial availability of GPS jammers is already an issue, as described by the CV Pilot lessons learned document:

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[29] J.D. Schneeberger, Amy O'Hara, Kellen Shain, Linda Nana, David Benevelli, Tony English, Steve Johnson, Steve Novosad, and Bob Rausch. *"Connected Vehicle Deployment Technical Assistance, Roadside Unit (RSU) Lessons Learned and Best Practice."* Performed by Noblis. Funded BY USDOT ITS Joint Program Office. May 2020. p. 27.

[30] Mike Brunker. "GPS Under Attack as Crooks, Rogue Workers Wage Electronic War." NBC News. August 8, 2016.

[31] E.g., https://greatscottgadgets.com/hackrf/one/

> "The New York City CV Pilot observed GPS jamming activity that prevented the RSU from operating and broadcasting connected vehicle messages. Jamming devices include radio frequency transmitters that intentionally block, jam, or interfere with lawful communications, such as cell phone calls, text messages, GPS systems, and Wi-Fi networks."[32]

Conclusion

Safety-critical applications cannot practically depend on a wireless network that is vulnerable to interference, regardless of licensed bandwidth or spectrum control rules.

2.3 Claim: 30 MHz is not sufficient for ITS operations

Most V2X advocates state quite strongly that 30 MHz of licensed ITS spectrum is not enough to provide the potential safety benefits. This argument typically centers on one of the following points:

International Examples

Several commenters claim that by allocating only 30 MHz of licensed spectrum for ITS purposes, the U.S. risks falling behind the international community. This is a difficult claim to parse. There is substantial variation internationally in how V2X networks are being considered for deployment. The only region that appears to be fully embracing C-V2X is China. However, China is not adopting cellular-V2X (C-V2X) as defined by 3GPP and international standards. China is adopting *CCP*-V2X as defined by the China Communications Standards Association (CCSA) and other national standards, as shown in Table 3 on page 10.

It is difficult to know how CCP-V2X differs from C-V2X without understanding Mandarin. It appears that China has adopted the physical layer standards of C-V2X but reinterpreted or replaced other standards to impose a national connected vehicles network that is integrated into a broader surveillance system for both persons and vehicles. The novel CCP-V2X network is likely intended to complement or supersede existing Chinese regulations for new energy vehicles

[32] Schneeberger (Noblis) et. al. p. 18.

(NEVs); these currently require that all electric vehicles share real-time location data with the Chinese National Government.[33, 34, 35]

TABLE 3: THE CHINESE V2X STANDARDS ARE DETERMINED BY CHINESE NATIONAL STANDARDS DEVELOPMENT ORGANIZATIONS.[36]

Standards Category	Standards	Standards Level	Standards Organization
Access Protocol	基于LTE网络的车联网无线通信系统总体技术要求	行标/国标	CCSA/TC485
	基于LTE的车联网无线通信技术空中接口技术要求	行标/国标	CCSA/TC485
Network Protocol	合作式智能运输系统 车用通信系统应用层及应用数据交互标准	团标	C-SAE/C-ITS
	基于LTE的车联网无线通信技术 网络层技术要求	行标	CCSA
	基于LTE的车联网无线通信技术 网络层测试方法	行标	CCSA
Message Protocol	合作式智能运输系统 车用通信系统应用层及应用数据交互标准	团标	C-SAE/C-ITS
	基于LTE的车联网无线通信技术 消息层技术要求	行标	CCSA
	基于LTE的车联网无线通信技术 消息层测试方法	行标	CCSA
Security Protocol	基于LTE的车联网通信 安全技术要求	行标	CCSA
	基于LTE的车联网无线通信技术 安全认证技术要求	行标	CCSA
	基于LTE的车联网无线通信技术 安全认证测试方法	行标	CCSA
Technical Reequipment Regulation	基于LTE的车联网无线通信技术 支持直连通信的车载终端设备技术要求	行标	CCSA
	基于LTE的车联网无线通信技术 支持直接通信的车载终端设备测试方法	行标	CCSA
	基于LTE的车联网无线通信技术 支持直接通信的路侧设备技术要求	行标	CCSA
	基于LTE的车联网无线通信技术 支持直接通信的路侧设备测试方法	行标	CCSA
	基于LTE的车联网无线通信技术 基站设备技术要求	行标	CCSA
	基于LTE的车联网无线通信技术 基站设备测试方法	行标	CCSA
	基于LTE的车联网无线通信技术 核心网设备技术要求	行标	CCSA
	基于LTE的车联网无线通信技术 核心网设备测试方法	行标	CCSA
	基于LTE的车联网无线通信技术 直接通信系统技术要求	团标	C-SAE/C-ITS
	基于LTE-V2X直连通信的车载信息交互系统技术要求	国标	NTCAS

While it is true that automakers are rapidly moving to deploy "C-V2X" in China, this is not necessarily by choice—and it is not the same technology that would be deployed in other markets with the exception of the proprietary chip set. It is also true that the Chinese government has moved forward very quickly to deploy "C-V2X," but this must be understood in context.

China's "C-V2X" network uses only a 20 MHz band, also.

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[33] Echo Huang. "A Chinese official explained how the country's electric car surveillance works." Quartz. January 14, 2019.

[34] Sean O'Kane. "Automakers give the Chinese government access to location data of electric cars." The Verge. November 30, 2018.

[35] Erika Kinetz. "In China, your car could be talking to the government." AP. November 29, 2018.

[36] Image source: Yu Shengbo. "Introduction of China C-V2X Industry and Standards." Presentation to ITU, September 9, 2020.

"Advanced Applications"

Several commenters have stated that at least 75 MHz of bandwidth is required for "advanced" V2X applications. These "advanced" applications currently do not exist beyond the conceptual phase. All current C-V2X pilot trials are using 3GPP Release 14 radio standards. "Advanced" applications that would be enabled by 3GPP Release 15 would require an interoperable carrier-neutral C-V2X network that does not currently exist (and there is no notable movement towards bringing such a network into existence). Other "advanced" applications that would be enabled by 3GPP Release 16 (the 5G stuff) may eventually be integrated into an open V2X ecosystem, but standards work on such applications has barely begun. Any of these advanced applications are considered "aspirational" by C-V2X experts.[37]

Autonomous Vehicles

Several commenters reference automated/autonomous vehicles as a specific "advanced" application that would be prevented by lack of licensed ITS spectrum. This belief has no foundation. There are no developers of fully autonomous vehicles who are depending on an interoperable ITS network for functionality. Several (including Waymo) have implied that they would *not* integrate V2X architecture or any other third-party wireless messaging service into vehicle control systems, even if it were available.[38]

One exception to this is that traffic signal data could be useful. However, architecting a safety-critical system that relies on wireless communication should use a secure and encrypted network. Thus, some developers *are* using signal integration but are not using DSRC or C-V2X. They are using proprietary solutions or LTE. For example, Audi has a traffic signal integration feature called "time to green."[39] This is often described as an application of C-V2X, but it is not, and thus is not relevant to this docket. The Audi green light advisory application uses LTE/Uu (3GPP Release 8) and thus is entirely unrelated to the 5.9 GHz band or C-V2X as defined by 3GPP and language proposed by the commission.

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[37] Jim Misener (of Qualcomm Technologies and 5GAA). (Jan 27, 2021.) "Today: Fitting Applications into One Channel. Tomorrow: Addressing Advanced Applications." ITS America Webinar. The Future of V2X: 30 MHz Application Map Webinar.

[38] Comments of WAYMO, LLC re: Proposed Regulation for Vehicle-to-Vehicle (V2V) Communication. NHTSA Docket NHTSA-2016-0126-0009. Posted April 25, 2017.

[39] This is not an AV application but is often described as a precursor to infrastructure-supported automation.

In fact, research by Audi and others have shown that existing LTE communication is sufficient for signal phase and timing (SPaT) data exchange, with a latency of under 300 milliseconds.[40] Given these findings, C-V2X (3GPP Release 14+) is *not* necessary for any SPaT applications, including but not limited to those that would assist automated vehicles.

Public Safety Vehicles and Public Service Fleets

A few commenters stated that additional bandwidth is required to enable the safe and effective operation of public safety and public service vehicles. It is unclear to what this may refer. Additionally, many public fleets have unique access to FirstNet and should be encouraged to utilize that valuable resource.[41]

Conclusion

All V2X applications architected to any degree of maturity can be accommodated with 20 MHz of spectrum. There is no justification for believing that 20-30MHz band of 5.9 GHz spectrum precludes essential safety-critical applications. Further, as discussed *supra* pages 2-7, there is no justification to conclude that V2X can support *any* safety-critical applications, regardless of licensed bandwidth.

2.4 Claim: V2X is mature and deployment-ready

V2X advocates have been describing DSRC technology as mature and deployment-ready for nearly a decade. However, pilot deployments have failed to demonstrate this. The ongoing Connected Vehicle Pilot Deployments were intended to validate safety applications but have slipped in schedule and have only reported partial results.[42] While NHTSA proposed to mandate V2V over a DSRC network in 2017, the NPRM was far from complete—requiring many critical aspects to be addressed before an FMVSS could go forward. By one count, NHTSA requested comment or clarification on over 50 items.[43] A recent "lessons learned"

[40] Dr. Alex Hainen, et al. "Co-Deployment of DSRC Radio and Cellular Connected Vehicle Technology in Tuscaloosa, AL and Northport, AL." Research performed at the University of Alabama and funded by Applied Signal, Inc. June 2020.

[41] https://www.firstnet.gov/

[42] See *supra* Table 2: Preliminary performance data from the Tampa CV deployment site shows that most warnings provided were false positives. Data is not available for applications that were abandoned due to technical difficulties.

[43] Eric Paul Dennis. "Review of NHTSA Proposal to Mandate V2V Communication for Safety." Center for Automotive Research (CAR) December 20, 2016. pp. 16-18.

document describing learnings from the ongoing CV Pilots is an excellent resource to quickly understand the inchoate nature of [DSRC-based] V2X technology.[44]

Trials are now underway to test the performance of C-V2X radio access technology. Preliminary results are positive, but there is very little data regarding full stack interoperability to the application level. Several standards remain in development.[45] This *work-in-progress* status of C-V2X may be the impetus behind one commenter proposing the Commission require *only the physical layer* of 3GPP Release 14+ to access licensed ITS spectrum. However, in absence of additional rules, this would imply that the licensed ITS spectrum would require use of the C-V2X chip set *but* interoperability would not be assured. Furthermore, it would seem that license holders would be required to self-determine what applications are "safety related." The Commission and other commenters should study this proposed language carefully.

One of the largest unknowns at this time is who will fund and operate a security credential management system (SCMS). The current SCMS implementations are partial proof-of-concept deployments. A fully interoperable nationwide SCMS will require substantial planning, testing, cooperation, and investment. Further, the concept of "privacy by design" should be reconsidered, as reidentification and tracking of vehicles broadcasting the BSM is easy.[46]

Conclusion

V2X is not a mature technology. Both DSRC (IEEE 802.11p) and C-V2X (3GPP Release 14) appear relatively mature at the radio level, but reliable interoperability across the full stack (to the application layers) has not been demonstrated for either technology and several applicable standards remain in development.

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[44] J.D. Schneeberger, Amy O'Hara, Kellen Shain, Linda Nana, David Benevelli, Tony English, Steve Johnson, Steve Novosad, and Bob Rausch. "Connected Vehicle Deployment Technical Assistance, Roadside Unit (RSU) Lessons Learned and Best Practice." Performed by Noblis. Funded BY USDOT ITS Joint Program Office. May 2020.

[45] Incomplete standards include SAE J3161 C-V2X Deployment Profiles (family of standards), and SAE J3224 – V2X Sensor Sharing for Cooperative and Automated Driving. Other standards may be targeted for updating in response gaps discovered in ongoing C-V2X trial deployments.

[46] The BSM is unencrypted. Anonymity is intended to be provided by randomly-assigned certificates, but an adversary could track a vehicle across certificate-swaps if receiving the signal during handover. Also, while the range of C-V2X PC5 communications Is only a few hundred meters to enable active safety applications, an adversary could achieve much higher coverage with an amplified antenna as vehicle location could still be tracked with substantial packet drops. This would be legal and untraceable as nothing is being broadcast on licensed spectrum—only receiving.

3 CLOSING

I have submitted this comment as an individual representing only myself. It does not reflect the view of my employer or any other organization with which I may be affiliated.

In this comment, I hope to have added to the public record critical details from V2X research that have not been addressed by other comments. I hope to have demonstrated the following:

- There is not sufficient evidence to conclude that V2X is a viable safety technology.
- Potential interference is a barrier to safety-critical communications regardless of licensed bandwidth or out-of-band emission control rules.
- "Advanced applications" that require greater than 20 MHz of bandwidth are "aspirational." All existing applications can be accommodated with 20 MHz of spectrum at 5.9 GHz.
- C-V2X applications remain in trial phase. While 3GPP Release 14 radio access technology is mature and demonstrated, no applications are shown to be deployment ready.

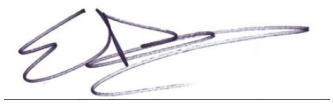
Considering these findings, the automotive and transportation industry should consider redirecting efforts to improve surface transportation to alternative technologies and policies.

I offer no position on spectrum allocation, but thank the Commission for their efforts to re-evaluate the 5.9 GHZ spectrum.

I would also like to thank the several individuals who assisted me in drafting this comment; yet any mistakes or omissions are solely my responsibility. This comment reflects and earnest interpretation of available research offered in good faith. If anyone can show that I have made mistakes in omission or interpretation, I will do my best to correct the record.

Communications can be directed to my Twitter DM @EricPaulDennis, or EricPaulDennis.MS.PE@gmail.com.

Respectfully submitted,



Eric Paul Dennis, PE
Ann Arbor, Michigan, USA – July 1, 2021